

are omitted, and the probability is that the arbitrator would be entitled to assess the value upon profits.

The second Bill is presented by Lord Houghton as representing the Board of Trade. The print of it has not yet been had, but it is understood to make no change in the objectionable features of the existing Act, but merely to add somewhat to the length of the term before the option of purchase arises. If this be so, it will still leave electric lighting as much "facilitated" as before, for there can be no increase of capital, and therefore no development, in an undertaking where, in a few years, the enjoyment of the interest upon that capital has come to an end, and where, when it does come to an end, a large portion of that capital will be confiscated.

Lord Houghton's Bill has this value, however—it shows, first, the length of time it takes the Board of Trade to admit they have made an error, and it shows, secondly, that it requires yet a still longer time to enable them to understand what that error is.

ELECTRO-DEPOSITION

Electro-deposition of Gold, Silver, Copper, Nickel, &c.

By A. Watt. (London: Crosby Lockwood and Co., 1886.)

IN the preface of this book is stated:—"The author's desire was to furnish" "a comprehensive treatise, embodying all the practical processes and improvements which the progress of science has, up to the present time, placed at our command." "The author's aim has been to treat the more scientific portion of the work in such a manner that those who are not deeply versed in science may readily comprehend the chemical and electrical principles of electrolysis, the knowledge of which is essential to those who would practise the art of electro-deposition with economy and success." How far he has succeeded in his desire and aim, and to what extent the contents of his book are suitable to electro-metallurgists and agree with its title, it is our duty as reviewers carefully to examine.

The book is essentially and almost exclusively a workman's manual. In accordance with this we observe that out of about 568 pages, only about 18 are strictly devoted to the fundamental principles or foundation of the subject.

It is evidently written and compiled by a "practical" man who has spent a long period of time in *electro-plate* workshops. It has various excellences and defects, the most important of which we will endeavour to point out. Its chief excellence consists in the remarkable completeness of information given respecting the details of workshop manipulation, in describing the treatment of nearly every kind of article requiring a coating of electro-deposited metal. The author has with great industry and perseverance collected a large amount of such information, and his book is especially full of details respecting the electroplating of articles with nickel. The information contained in it is, with certain exceptions, well up to date, and the printer's errors are remarkably few. It has also the advantage of a copious index consisting of nearly 50 pp., and the subject-matter of the book is conveniently divided into chapters of moderate

length, with the contents of each chief paragraph plainly indicated by bold headings.

Its greatest defects are those of omission; it is seriously deficient in the chemical, chemico-electric (*i.e.* voltaic), and electro-chemical (*i.e.* electrolytic) principles of the subject. Throughout the volume nothing is said respecting the fundamentally important matter, both theoretically and practically, of the chemical valency of the elementary substances; the chemical, voltaic, and electrolytic equivalents of those elements are also neither given nor explained. On p. 513 a table of atomic weights of the chemical elements appears, but as only a portion of these are equivalent to each other, and those not indicated, they would, without the valencies or a separate table of combining-proportions, in many cases only mislead an unscientific workman. The only indication of any difference existing between atomic-weight and chemical-equivalent is contained in a footnote to that table, saying, "the combining-weight of oxygen is 8."

From beginning to end of the book, the molecular and equivalent weights of all the compound substances employed in electro-deposition are omitted; none are given even for the commonest substances, such as sulphuric acid, potash, soda, lime, double cyanide of silver and potassium, blue-vitriol, potassic cyanide, double sulphate of nickel and ammonium, &c.; similar remarks may be made respecting the salts of zinc, cadmium, lead, tin, iron, nickel, copper, silver, gold, palladium, platinum, bismuth, antimony, &c.; also respecting hydrochloric, nitric, and other acids. Almost the only exception appears to be on p. 483, where it is said, respecting the salt used for making nickel-plating solution:—"The double salt consists of 1 atom of sulphate of nickel, 1 atom of sulphate of ammonium, and 8 of water."

Throughout the book also the chemical formulæ of all those compounds are omitted, notwithstanding that they would enable the workman to arrive in many cases at the chemical equivalents by comparing them with the atomic weights, and would also assist him to more perfectly realise and remember the actual chemical composition of the acids, bases, and salts used in his occupation.

In accordance with these omissions, no principle or general rule is supplied which will enable the operator to calculate how much in weight of a given metal or base would be necessary to neutralise a known amount of a particular acid, nor what quantities of acid and base would be required to form a certain weight of a salt, in making and correcting his various solutions; nor how much current would be generated by the consumption of known amounts of different positive metals or of different acids; nor what quantities of different metals would be deposited at the cathode, or of unlike ones dissolved at the anode, by the passage of a given amount of current through an electrolyte. Respecting this latter point, on p. 72 it is, however, stated:—"The decomposing effects produced by the voltaic current in different electrolytes are precisely in accordance with the *atomic-weights* or *chemical-equivalents* (which see) of the substances electrolysed." "For example, the same amount of electricity that would reduce 56 parts of iron from its solution to the metallic state, would reduce 207 parts of lead or 108 of silver." But the "chemical-equivalents" to which the reader is here referred are not to be seen in the book,

nor does the table of "atomic-weights" necessarily indicate them; and either the above numbers given by the author for iron and lead are double the correct amounts, or that for silver is only half the proper quantity. This is an example of the misleading effect we have already referred to, of the table of atomic-weights, when unaccompanied by valencies or by one of combining-proportions, and used by a person unacquainted with the difference between atomic-weights and chemical-equivalents. The nearest approach to information respecting chemical-equivalents is indicated on p. 480, in instructions for testing the strength of potassic cyanide, but this is applicable only to the particular substances employed in the case. Any electro-depositor therefore who, relying upon the information contained in this book, wished to calculate the cost of depositing various metals, or to make experiments or improvements in his processes, outside the mere empirical or "rule-of-thumb" circle of knowledge, and involving chemical principles, would not be enabled to do so; in novel cases of difficulty in electro-deposition also, this deficiency of knowledge of chemical principles might prove a great disadvantage to him.

On p. 80 the writer says:—"It is necessary, in the present advanced state of electrical science, that both the student and practical operator should be acquainted with the principles and laws which govern the development of electricity;" and in the preface he speaks of "the chemical and electrical principles of electrolysis," "the knowledge of which is essential to those who would practise the art of electro-deposition with economy and success." But notwithstanding these statements, the important matters we have mentioned are omitted, and the student and practical operator are referred (pp. 80-90) "for a more intimate acquaintance with the principles of voltaic and dynamic electricity" to other books.

We observe that in Chapters V. and VI., on the theory of the subject, nothing is said about the thermal principles of electrolysis, or of the absorption and evolution of heat by chemical changes at the surfaces of the plates in voltaic and electrolytic cells. In the chapters on electro-deposition and electro-metallurgy of copper, the chemical analyses made by the Duke of Leuchtenberg (p. 395) and others, showing the composition of the insoluble matter of the anodes, are not given. The special defect of thermo-electric piles, viz. that they are only durable if kept at unvarying temperatures, is also not mentioned. And nothing is said of the presence of sulphur in electro-deposited "bright" silver. These, however, are much less important omissions.

The errors in the book are not many; we have observed the following:—"Nine parts of water consist of one part, *by weight*, of hydrogen, and eight parts, *by weight*, of oxygen; or by volume, 1 part hydrogen and 16 parts oxygen" (p. 74); the error is obvious. Roseleur says, "that solutions of cyanides, even without the aid of the electric current, rapidly dissolve in the cold, or at a moderate temperature, all the metals, except platinum" (p. 174); this statement of Roseleur's is not quite correct, iron is nearly as little dissolved as platinum, in a cold solution of pure potassic cyanide.

The author says that for containing cyanide of silver plating solution, "wooden tubs may be employed for small operations, but since that material absorbs the

silver solution, such vessels should be well soaked in hot water before pouring in the solution" (p. 241). We may remark that such soaking does not prevent the wood becoming saturated with the silvering liquid.

On p. 270 it is stated that a solution of sulphide of potassium "dissolves" silver. This is not correct; it converts the surface of the silver into sulphide without dissolving either. On p. 365 the author speaks of "Chevalier Bunsen's methods" of electrolysis. We may state that the "Chevalier," and Bunsen the chemist, whose methods are referred to, are two different persons.

In various parts of Chapter XXX., on the electrolytic refining of copper, the author, speaking of where this process is in use, says:—"Besides Messrs. Elkington's works at Pembrey, South Wales," "by the Elliott Metal Refining Company at Selly Oak, near Birmingham, where Wilde's machines are employed." And under the heading of "Electrolytic Refining at Birmingham," he says:—"The Elliott Metal Refining Company, of Selly Oak, near Birmingham, employ five large Wilde machines, which refine about ten tons of copper per week;" and he then gives a variety of particulars respecting the arrangements employed, the "thickness of deposit" of copper per week at the "Selly Oak Works, Birmingham;" the "cost of electrolytic copper refining" at those and other works, based partly upon the cost of fuel "in Birmingham and Swansea," &c. (pp. 416, 420, 423, 424, 425). All this is founded upon a mistake; there is not, nor ever has been, any "electrolytic refining of copper," nor any plant for such a purpose, at "Selly Oak" or at "Birmingham," or anywhere near those places. This error appears to have been first published by M. Fontaine in his book on "Électrolyse," then copied by Berly in his English translation of that book, and again copied by Watt. The explanation and facts are: the Elliott Metal Company, of Selly Oak, near Birmingham, possess and carry on the Electrolytic Refining Works at Pembrey, near Swansea, formerly possessed by Messrs. Elkington.

The redundancies in the book are considerable; the following are examples:—Description of several voltaic batteries which are rarely used for electro-deposition, viz. Callan's, Walker's, Leclanche's, the bichromate, and Marie Davy's (pp. 11, 13, 15, 16); an account of Mr. Charles Watt's magneto-electric machine (p. 25); description and engraving of Mr. C. Watt's thermo-electric battery (pp. 42-45); the source, mode of collecting, and purifying gutta-percha (pp. 94, 95); gilding metals with gold leaf (p. 195); processes and compositions for colouring ordinary gold articles by chemical means (pp. 198-201); mercurial gilding, gilding bronzes with amalgam, ormolu (pp. 202-208).

A considerable portion of the book also is occupied by information which, although very useful to jewellers and other workers in metal, does not strictly belong to the subject of "Electro-deposition;" we allude to the following:—Driving-belts (pp. 487-493); gas-engines (p. 492); speed indicator (p. 497); characteristics of metals (pp. 498, 499); alloys (pp. 500-504); soldering metals (pp. 504-507); table of high temperatures (p. 515); tables of different wire-gauges (p. 517).

In various parts of the book, whilst there is an excess of details of manipulation, there are very few references to general principles, as if the main object of the author

was to enable the workman to compensate for deficiency of knowledge of scientific laws by means of "rule-of-thumb" experience and by remembrance of a multitude of empirical instructions. In order therefore to enable the artisan reader to make the best use of the book, we would recommend him to previously learn sufficient of the principles of chemistry and of voltaic and electrolytic action, and then master the very numerous practical details of this book.

Repetitions of small matters are frequent in the book; in more than twenty instances the same statement has been made in modified forms, from two to four times. These repetitions are most frequent in the chapters on deposition of nickel.

In consequence of the considerable redundancies, the large amount of extraneous matter, the excess of details of manipulation, and the repetitions, a large quantity of matter might have been omitted, and the contents of the book would have been rendered more in accordance with the title. According to the present contents, a more appropriate title would have been "Manipulations in Electro-deposition," &c.

The writer of the book makes the following statement on p. 213; speaking of "cheap jewellery" he says: "The author has found it a very convenient plan to use a copper anode for gilding work of this description, and by making small additions of chloride of gold when the bath exhibited signs of weakness, he has been able to gild a very large number of articles of a very fine colour, with an infinitesimal amount of the precious metal. In his experience, although the prices were very low, the result was exceedingly profitable. Against the employment of a copper anode it has been argued that the solution must of necessity become highly impregnated with copper, to which we may reply that we did not find such to be the case in practice." The circumstance he mentions—that the solution "did not become highly impregnated with copper" is easily and correctly explained: the solution did become charged with copper, but not "highly," because the copper was deposited as fast as it was dissolved in alloy with gold upon the articles, and thus produced the "very fine colour," and conduced to the "exceedingly profitable" character of the result. A complete proof of this is afforded by the author on p. 197 of his book, in his instructions for depositing alloys of gold.

On p. 214 he very truly remarks: "The introduction of the electro-gilding art greatly favoured such unscrupulous persons as desired to prey upon the public by selling as gold, electro-gilt articles which had not a fraction of the precious metal in their composition." As an example of this he mentions "mystery-gold," and states that "the chief aim of the manufacturers" of articles made of that composition "is to defraud pawnbrokers."

In Chapters XXIX., XXX., and XXXI., on "Electro-metallurgy," the author has copied and collected together, from Fontaine and Berly's books on "Electrolysis," and various periodicals, &c., nearly all the information yet published respecting the electrolytic refining of crude copper, lead, zinc, &c., on the commercial scale, and the economic extraction of metals from minerals by the aid of electrolysis. Six pages of those chapters are devoted to a description, with drawings, of Cowle's electric furnace.

But this furnace is not "electrolytic": it is one in which an intense heat is obtained by means of the electric arc on a large scale in an inclosed fire-resisting chamber, in which carbon at an enormous temperature reduces aluminium and silicon from their oxides, and those reduced elements form alloys with copper previously mixed with the carbon. Much of the information contained in these chapters is useful, but a large portion of it relates to new processes, and partly unsuccessful experiments on a large scale; and as some of those processes are imperfect and in a state of development, the statements made respecting them should be received with caution.

In consequence of the serious deficiency of information respecting the chemical, voltaic, and electrolytic principles of the subject, we do not consider that the author has succeeded in his aim "to treat the more scientific portion of the work in such a manner that those who are not deeply versed in science may readily comprehend the chemical and electrical principles of electrolysis." But notwithstanding the fundamental and minor defects which we have pointed out, as the details of workshop information and manipulation contained in the book are so copious and complete, we think he has substantially attained his "desire to furnish a comprehensive treatise embodying all the practical processes and improvements in the art of electro-deposition"; and, irrespective of its shortcomings, the book will prove of great value to many electro-depositors, jewellers, and various other workers in metal.

OUR BOOK SHELF

"Weatherology" and the Use of Weather Charts. By Campbell M. Hepworth, R.N.R. (London: Laurie, 1886.)

METEOROLOGISTS must wish success to this endeavour of Capt. Hepworth's to popularise their technical phraseology, and to explain how the public can utilise the weather-charts which appear daily in the *Times* and *Lloyd's List*, in combination with local observations of wind, sky, and weather. The author has considerable sea experience in the North and South Atlantic, and he imparts the results of it freely, but his language is still rather too scientific for an ordinary reader.

Without being hypercritical, we must take exception to two statements. The definition of a "gradient" is defective, for no mention is made of the unit of barometrical difference (0.01 inch), which is employed, while the modern unit of distance is 15 miles, not 60.

Again we must protest against fathering on Admiral FitzRoy (p. 5) the form of siphon barometer which is sold for a guinea, and sometimes is called after him, sometimes dubbed the "Polytechnic barometer." There is no authority to connect the Admiral with it, as either inventing or even approving of it.

ROBERT H. SCOTT

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Residual Magnetism in Diamagnetic Substances

IN the account which Prof. Lodge gives of his very interesting experiments (*NATURE*, March 25, p. 484) he describes an